Why is weight loss so difficult?
Cognitive Processes might interfere

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“GENES LOAD THE GUN, THE ENVIRONMENT PULLS THE TRIGGER” (BRAY)

NEVERTHELESS: LIFESTYLE CHANGE...!!

Faculty of Psychology and Neuroscience

www.eetonderzoek.nl

Friday, May 24, 13
LIFESTYLE TREATMENTS (IN SHORT):

- Nutritional counseling/diet management: “you have to eat healthy!”
- Psycho-education: “fat, carbs, sweets, snacks: bad for you”
- Exercise/physical activity increase: “you should exercise!”
- In general, these interventions do NOT work well: also when obese people do know how to behave, they do not easily succeed in changing their behavior...
It is expected that people CAN change if they just WANT to

However, cognitive mechanisms might interfere...

how do they resist their desires to (over)eat?
WEIGHT LOSS GENERALLY NOT SUCCESSFUL

* Surprisingly little attention to cognitive processes in obesity
* Improved understanding of cognitive maintenance factors that predict overeating and weight (re)gain should inform more effective treatment programs
MISSING KNOWLEDGE:

- Why do some people overeat?
- Why do they keep overeating?
- Why do they (not) succeed in eating less?
- How to change bad eating habits?
- How to resist desires to eat?
WHAT DO WE ACTUALLY KNOW ABOUT THE MAINTAINING MECHANISMS OF ‘OBESE EATING’?

HOW DO WE TACKLE THEM IN TREATMENT?
Not everybody grows obese: individual differences

Why are some people more vulnerable than others?
Genes

- About 67% of the variability in BMI has a genetic basis (Ravussin & Bogardus, 2000)
- Only ±10% of this genetic predisposition is related to metabolic rate or 'biology'...
- The largest part is related to eating behaviour: “hyperresponsivity to tasty food cues” (Wardle, 2010, Carnell et al 2008; Llewellyn et al 2010)
CUE REACTIVITY

‘hyperresponsivity to tasty food cues’ = cue reactivity (Jansen, 1998; Wardle, 2010, Carnell et al 2008; Llewellyn et al 2010)

Cue reactivity = desire to eat / urge to eat that is induced by cues and/or contexts that are associated with eating

partly genetic, partly learned
FOOD CUE REACTIVITY

• Is stronger in the obese

• Increased ‘cue reactivity’ → motivates eating – in excess of calories needed → eating more when confronted with cues → increased obesity risk
Mechanism:
cue reactivity
**Most Potent Cues:**

- Seeing, smelling, tasting foods
- Thinking of foods and tastes
- Contexts (home, kitchen, television, eating places, persons to eat with, etc.)
- Feelings/emotions
- Cues increase risk of overeating / relapse
Cued overeating in obese children (8-12)

Salivation increase – food intake obese: \( r = 0.62 \)

Jansen et al. 2003 Eating Behaviors
Learned Context Reactivity
Virtual Reality Lab
Expectancy & Desire

CS+

CS-

CS+

CS-
Context-induced salivation

![Graph showing mean salivation levels for Baseline, CS+, and CS- conditions. The graph indicates a significant increase in salivation for the CS+ condition compared to Baseline and CS- conditions.]

van den Akker, Jansen et al., Appetite, in revision
IMPULSIVE PEOPLE: INCREASED CONTEXT-INDUCED INTAKE

van den Akker, Jansen et al., Appetite, in revision

Friday, May 24, 13
Impulsive people show increased cue-elicited craving.

**Fig. 3** Mean increase in craving and S.E.M. of the heavy and light drinkers according to their response inhibition levels (as measured with the SST) during the alcohol cue-exposure condition.
Cue reactivity makes dieting/weight loss more difficult: Obese vs. Post-obese
### Successful weight loss maintenance

<table>
<thead>
<tr>
<th></th>
<th>Obese (n=12)</th>
<th>Post-obese (n=12)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>age</strong></td>
<td>45.8 (9.4)</td>
<td>40.5 (11.3)</td>
</tr>
<tr>
<td><strong>Current BMI</strong>*</td>
<td>34.3 (3.8)</td>
<td>24.7 (2.3)</td>
</tr>
<tr>
<td><strong>Highest lifetime BMI</strong></td>
<td>35.5 (4.7)</td>
<td>35.3 (6.8)</td>
</tr>
<tr>
<td><strong>Starting BMI last diet</strong></td>
<td>35.5 (4.7)</td>
<td>34.9 (6.9)</td>
</tr>
<tr>
<td><strong>% weight loss</strong>*</td>
<td>3.0 (4.3)</td>
<td>27.2 (12.1)</td>
</tr>
<tr>
<td><strong>Eating restraint</strong>*</td>
<td>3.2 (0.6)</td>
<td>3.7 (0.7)</td>
</tr>
</tbody>
</table>
Salivary Response

- Obese: Decrease
- Post-obese: Increase

Baseline vs. Food Cues
SUCCESSFUL DIETING

- Restricted eating is much easier without food cue reactivity (appetitive responding)
- Cue reactivity extinguishes when exposure to foods systematically remains unreinforced
- We can help dieters to extinguish their cue reactivity
Clinical Implication

cue exposure
(extinction training)
EXTINCTION TRAINING

- Exposure to cues/contexts – without intake (response prevention)
- It is learned that the cue/context predicts NO eating
desire to eat during context cue exposure: extinction

Jansen et al., yet unpublished data
Reduction % overeating episodes

context cue exposure

pre  post  FU-6m  FU-12m

-100 -75 -50 -25 0
Some studies suggest CERP being effective:

- Jansen et al 1992 / recent data in prep
- Toro et al. 2003
- Martinez-Mallen et al 2007
- Boutelle et al. 2011

- BUT: small-scaled
- NEED for RCTs
- AND need for study process of change
dieting

exposure to palatable foods
NO eating

extinction of learned cravings

easier dieting
(successful dieting)
dieting

sabotage of dieting (unsuccessful dieting)

NO extinction of learned cravings

intermittent overeating on palatable foods

sabotage of dieting (unsuccessful dieting)

NO extinction of learned cravings

avoidance of palatable foods
PRIMACY OF THE BRAIN?

- CERP: increased brain reward responding followed by decreased brain reward responding (±1 hour)
- feelings of craving show slower extinction: brain craving stops before you feel it

Frankort et al., The craving stops before you feel it: neural correlates of chocolate craving during cue exposure with response prevention. Cerebral Cortex, in press
To sum up

- reactivity to cues (including emotions) and contexts induces (over)eating: emotional and habitual overeating
- Cue reactivity makes weight loss (maintenance) extremely difficult
- Extinction training (Cue Exposure with Response Prevention) reduces cue reactivity and facilitates dieting
Mechanism: impulsivity
Impulsivity

- Inability to resist impulses and temptations, direct responding without thinking.
- Lack of self-control to refrain from acting:
  - being unable to inhibit responses
  - being very sensitive to rewards
response inhibition
Stop Signal Task for children / adults
press left
press right
system adapts to the individual: 50% of inhibition responses is successful
• Reaction Time: time (msec) needed to press
• Stop Time: time (msec) needed to stop
• The more stop time is needed, the more impulsive one is

![Image of green check mark and red X]
obese children significantly worse in response inhibition

stop signal task

healthy weight

obese

Nederkoorn et al., 2006a, 2006b, 2006c; BRAT, Appetite, Eating Behaviors
Very ROBUST finding:

- Overweight/obese adults and children are significantly more impulsive compared to healthy weight controls (e.g., Nederkoorn et al., Guerrieri et al., Davis et al)

- Inducing impulsivity using SST increased food intake (Guerrieri et al., 2009)
Impulsivity & treatment succes

- CBT for overweight/obese children
- Before treatment: SST
- BMI – SSRT: $r = 0.49$; more obese = more impulsive
- Impulsivity predicted weight loss: more impulsive children lost sign fewer pounds
- impulsivity reduces the effect of obesity treatment

Nederkoorn et al., 2007 BRAT
Obese Cognitive Profile

cue reactivity

impulsivity
Inhibition Training (Houben & Jansen, Appetite, 2011)

- Chocolate lovers
- GO/NO-GO computer task
- Pictures: chocolat, neutral, fillers
- Followed by cue (1500 msec)
  - + GO Cue = press space bar
  - + NO-GO cue = do not press
- 2 x 160 trials
3 Conditions:

1. Inhibit responses to choc: all choc-NO-GO cue
2. Respond to choc: all choc-GO cue
3. Respond in 50% of trials (control); 50% pictures GO, 50% NO-GO
Intake after training

Sign interaction, p=0.01

Houben & Jansen, Appetite, 2011
decreased consumption of food associated with NO-GO cues
reward sensitivity
REWARD SENSITIVITY

- experienced pleasure or reinforcement
- related to DA transmission in brain reward regions
- Measure RS with computer tasks and/or fMRI (self-reports unreliable in case of weight / eating problems)
Open Door Task

You have 8 points.
hoera!

1 punt gewonnen!
jammer!

1 punt verloren
Open Door Task

- Start: 90% gains
- Gains decrease in steps of 10%
- Finally gains are 0%
- Normally, one stops the gambling when the chance to win is about 50%
- Going on means that one is more sensitive for reward/reinforcement and less sensitive for punishment
children $M_{\text{age}} = 13.7$ yrs

Nederkoorn et al., 2006 Eating Behaviors
overweight = reward sensitive

- Overweight children gamble longer; losses do not influence behavior
- Reinforcement strengthens the behavior of the overweight child
- Punishment does not stop the behavior of the overweight child
- Obese adults more often choose high immediate gain and larger future losses in gamble tasks (Davis et al., 2004)
Food Reward

- Liking: enjoying the taste
- Wanting: motivation to work for the food
- How hard do people work for high calorie foods?
Working for food - computer task

- task: to earn 100 points
- 10 points earned = 10 g foods
- the food has to be eaten
- 100 points = 100 g foods
- E.g., 40 points for fruits = 40 g fruit
- 60 points for cookies = 60 g cookies
You can choose:
Press left or right to earn a point
Unfortunately NO point

0 0
You can choose:
Press left or right to earn a point

0 0
Jeah! A point!
BUT:
It is not that easy to earn snack points
## Reward value of snacks:

<table>
<thead>
<tr>
<th>Phase of task</th>
<th>Fruit &amp; vegetables</th>
<th>snacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fase 1</td>
<td>2 x press = 1 point</td>
<td>2 x press = 1 point</td>
</tr>
<tr>
<td>Fase 2</td>
<td>2 x press = 1 point</td>
<td>4 x press = 1 point</td>
</tr>
<tr>
<td>Fase 3</td>
<td>2 x press = 1 point</td>
<td>8 x press = 1 point</td>
</tr>
<tr>
<td>Fase 4</td>
<td>2 x press = 1 point</td>
<td>16 x press = 1 point</td>
</tr>
<tr>
<td>Fase 5</td>
<td>2 x press = 1 point</td>
<td>32 x press = 1 point</td>
</tr>
</tbody>
</table>

How hard is one willing to work to get high-calorie snacks compared to healthy fruits?
responses for snacks

Between: Group
Within: Trial
Covariate: Hunger

Giesen et al., 2009, BRAT, Giesen et al 2010 Health Psychology

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To sum up

- The obese are reward sensitive
- Reward based eating is unrelated to energy needs
- Motivated by the expected pleasure of taste
- The obese gamble longer for rewards – general reward sensitivity
- The obese work harder for high-calorie foods – specific food reward sensitivity
Obese Cognitive Profile

↑ cue reactivity

↑ impulsivity

↑ reward sensitivity

↓ response inhibition
Executive functioning

• executive functions: a set of processes that all have to do with managing oneself and one's resources in order to achieve a goal

• It is an umbrella term for the neurologically-based skills involving mental control and self-regulation
SOME RELEVANT EXECUTIVE FUNCTIONS

- **inhibition**: ability to stop one’s behavior at the appropriate time
- **shift**: ability to think flexibly in order to respond appropriate to a situation
- **emotional control**: ability to modulate emotional responses by rational thinking
- **working memory**: capacity to hold information in mind to complete a task
- **self-monitoring**: ability to monitor one’s own performance and to measure it against a needed or expected standard
EXECUTIVE FUNCTIONS IN OBESITY

- Obese dysfunctional executive profile: (inhibitory control - emotional regulation): decreased performance in decision making, response inhibition, cognitive flexibility (Fagundo et al., 2012, PLoS ONE)
- Same profile found in Anorexia Nervosa
Prefrontal activity - control

• Obese subjects: low prefrontal metabolism. BMI + prefrontal metabolic activity are negatively associated (Volkow et al., 2008, Neuroimage; Volkow et al., 2008, Obesity)

• Successful dieters: increased Prefrontal Cortex (PFC) activity (inhibitory control) (Delparigi, et al., 2006, International Journal of Obesity; Sweet et al., 2012, Obesity)
Clinical Implication

increase prefrontal control
decrease brain reward activity
Cognitive Modulation

Is it possible to cognitively manipulate PFC activity? To train the obese to increase PFC activity? (Siep et al., 2012, *Neuroimage*)
Manipulation I: Up-regulation

When you see this arrow increase your cravings for the shown foods.

You can achieve this by thinking about:
- Its wonderful taste
- Its delicious smell
- How good it would feel to experience the food inside your mouth

............
Manipulation II: Suppression

When you see this ‘stop sign’ you **suppress your cravings** for the shown foods.

Try to perceive the food in a neutral way.
When you notice any thoughts about food tastes or smells, stop them immediately!
Manipulation III: Reappraisal

When you see this ‘eye’ try to perceive the shown foods differently.

Think about the negative consequences of the foods for:
- Your weight
- Your health
- Your body image
“I’m craving one or more specific foods”
CRAVING

Upregulation
Suppression
Reappraisal

(Siep et al., 2012, Neuroimage)
fMRI: reward activity

(Siep et al., 2012, Neuroimage)

Left Insula

Right Insula

Left Ventral Tegmental Area

Right Somatosensory Cortex

Upregulation increases reward activity | suppression & reappraisal decrease

Friday, May 24, 13
fMRI: control activity
(Siep. 2012 Neuroimage)

Left Anterior Prefrontal Cortex

Right Anterior Prefrontal Cortex

Left Ventral Tegmental Area

Suppression increases prefrontal control activity (but reappraisal does not)
Conclusions

- Reward sensitivity stimulates working for snacks – and eating it...
- Imagined taste evaluation: increased activity in brain reward centre in the obese (Frankort et al., IJO 2011)
- Needed are strategies to reduce reward value of high calorie foods
- It is possible to change brain reward activity & craving through cognitive modulation
- Study more ways to decrease reward value of unhealthy foods and/or reward sensitivity of the obese
CLINICAL IMPLICATION:
Learning to increase control

Working Memory Training
Working memory training

- Working memory; ability to maintain and manipulate goal-relevant information
- WM weak; behavior strongly guided by impulses – out of control
- Training WM to restore control
Working memory training

Houben, Wiers & Jansen, Psychological Science, 2011

- N = 48 problem drinkers
- Training WM (visuospatial task, backward digit span task, letter span task)
Fig. 1. Mean working memory span of participants in the training and control conditions at the end of each training or control session. For each session, working memory span was averaged across the three working memory tasks. Error bars represent standard errors of the mean.
WM training improved WM

Fig. 2. Estimated marginal means for the working memory tasks at pretest, posttest, and follow-up, separately for participants in the training and control conditions. Error bars represent standard errors of the mean.
WM training reduced alcohol intake

Fig. 3. Estimated marginal means for weekly alcohol use (number of alcoholic drinks per week) at pretest, posttest, and follow-up, separately for participants in the training and control conditions. Error bars represent standard errors of the mean.
OBESITY TRAINING

Training working memory may also provide the overweight/obese with a stronger ability to resist temptation and to better control eating habits.

Verbeken et al 2013: executive functioning training (inhibition & working memory) vs treatment as usual - obese children.
EF training: 25 × 40 minutes computer-based training (6 weeks)
Mechanism:

attention bias

increased attention for / interference by a specific set of cues compared to other cues
Attention Bias for high fat foods (HFF) in obese people: more frequent initial orientation towards HFF in obese followed by reduced attention for HFF = approach - avoidance

Craving positively associated with initial orientation

Attention pattern followed by sign higher intake in obese

Werthmann et al., 2012, Health Psychology
Clinical Implication

Attention Bias Modification Training
AB MODIFICATION TRAINING

- No effect on craving & intake
- However, many errors in performance
- Only correct performance (80%): training related to intake
- Also in addiction and anxiety studies mixed findings on effects of ABM procedures
Mechanism: negative affect
INCREASED DEPRESSION RISK

Treatment studies: Obese more frequently depressed (Baumeister & Harter, 2007; Faith et al., 2002; Grilo et al., 2001; Kasen et al., 2007; Nauta et al., 2000; Werrij et al., 2006, Werrij et al., 2009)

Population studies: Obese more frequently diagnosed depression (Scott et al., Meta-analyse 2007)

Depression might be an obstacle for weight loss
MOTIVATION TO LOSE WEIGHT AND NEGATIVE AFFECT

BMI change as a function of dieting motivation and depressive symptoms

Roefs et al., 2012, journal of social and clinical psychology
AFFECT & OBESITY

Non-clinical obese sample n=195

Cluster analysis on affect (BDI, PANAS, RSE)

2 clusters - no difference in BMI:
- High Negative Affect (n=92, 47%)
- Low Negative Affect (n=103, 53%)

(JANSEN ET AL., 2008 APPETITE)
**REGRESSION ANALYSIS**

- Body shape and weight concerns, not BMI, predict high negative affect: 32% of negative affect variance was explained by shape/weight concerns.
- Note that there were NO differences in BMI (body shape/weight) between HNA and LNA.
- Body image dissatisfaction mediates between obesity and depression: increased body dissatisfaction: more depressed (Friedman et al., 2002).
conclusion

- Motivation to lose weight and depression interact: strong motivation and high negative negative affect less weight loss than strong motivation without negative affect
- Negative affect associated with body weight/shape dissatisfaction
- Clinical implication: treatment modules to improve body satisfaction and to decrease negative affect
Obesity treatment Maastricht study

- N=200 overweight/obese (BMI = 33.4, range 27–52.3)
- Randomly assigned to:
  - dietetic treatment + physical exercise
  - dietetic treatment + cognitive therapy
- CT: change of dysfunctional thinking about eating, food, body, self-esteem
- 10 weekly 2 hr sessions
- In groups up to 12 participants

Werrij, Jansen, Mulkens et al., (2009) CT prevents relapse in obesity. J of Psychosomatic Research
Werrij, Jansen, Mulkens et al., (2009). J of Psychosomatic Research
CONCLUSIONS

 Obesity is a behavioral and cognitive condition

 Current behavioral / lifestyle treatments usually do not focus on cognitive maintenance mechanisms – because knowledge is lacking – and are therefore not very successful

 Bad eating habits can be changed by cognitive interventions that tackle the maintenance mechanisms
COGNITIVE BEHAVIOR THERAPY NEW STYLE

Obese Cognitive Profile

- Food attention bias
- Prefrontal cortex ('control') activity
- Executive functioning
- Reward sensitivity
- Response inhibition
- Cue reactivity
- Impulsivity
- Pos/neg affect
- CUE EXPOSURE
- BODY EXPOSURE / COGNITIVE THERAPY
- INHIBITION TRAINING
- WORKING MEMORY TRAINING
- COGNITIVE THERAPY / MINDSET TRAINING
CONCLUSIONS CONTINUED

Much more experimental research is needed into relevant cognitive maintenance mechanisms...

and into their clinical implications – how to tackle these maintaining mechanisms...

and into the dissemination of the effective interventions...

thank you, thanks to the Maastricht Eating Research Group: www.eetonderzoek.nl